The CERCular
Coastal Engineering Research Center

CERC-96-3 September 1996

Design for Wave Protection at Newport North Marina, Yaquina Bay, Oregon

by Robert R. Bottin, Jr.

Introduction

The Yaquina Bay Estuary is located on the Oregon coast about 185 km (115 miles) south of the Washington border. The major tributary to the estuary is the Yaquina River, which drains approximately 650 sq km (250 sq miles) of largely forested area on the west side of the Coast Range. Two rubble-mound jetties have been constructed at the mouth of the Yaquina River. The north jetty is 2,134 m (7,000 ft) long and the south jetty is 2,621 m (8,600 ft) in length. The distance between the jetties is 305 m (1,000 ft) at their outer ends.

Newport North Marina is situated on the north bank of the Yaquina River about 3.2 km (2 miles) upstream from the seaward ends of the Yaquina River jetties (Figure 1). The marina was constructed in 1946 and includes an 808-m (2,650-ft) timber breakwater that protects a small-boat marina from wave action. The crest of the timber structure was constructed to an elevation (el) of +4.3 m (+14 ft) relative to mean lower low water (mllw). The mooring areas in the marina were dredged to a depth of -3 m (-10 ft). A 1994 aerial photograph of the Newport North Marina is shown in Figure 2.

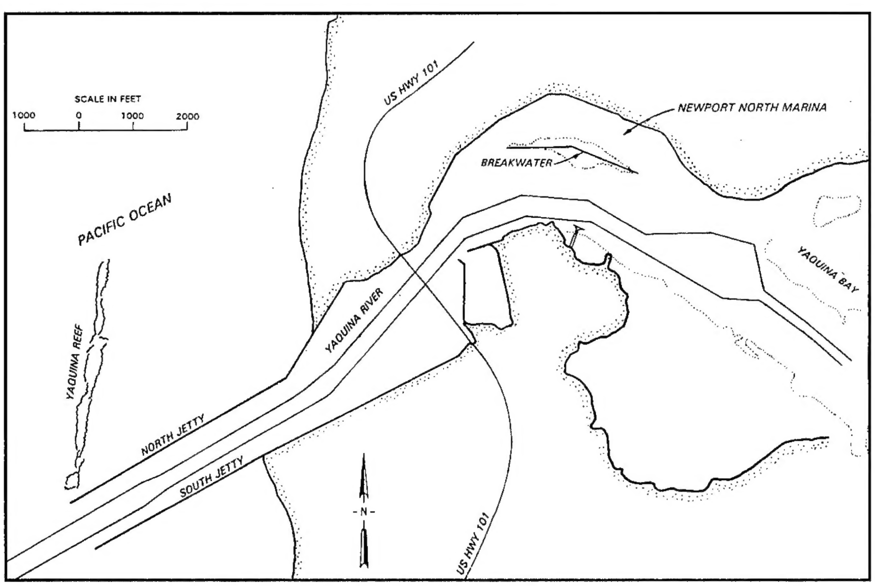


Figure 1. Newport North Marina relative to Yaquina River

Newport North Marina experiences excessive wave energy due to waves from the Pacific Ocean propagating through the west entrance. The majority of the problems are experienced in the western one third of the marina during winter storms at high tide stages. Waves ranging from 0.9 to 1.2 m (3 to 4 ft) have been observed in the marina during storm events. In November 1981, a "3-year storm event" destroyed a port dock and caused $720,000 in damages to the marina. Another dock experienced damage to water and electrical lines during January 1990 storms. Overtopping of the existing, deteriorated timber breakwater may occur as often as four to six times during one winter. Little wave energy appears to enter from the marina's east entrance.

The Model and Appurtenances

At the request of the U.S. Army Engineer District, Portland, (NPP), a three-dimensional physical model was constructed at the Coastal Engineering Research Center to study wave conditions at Newport

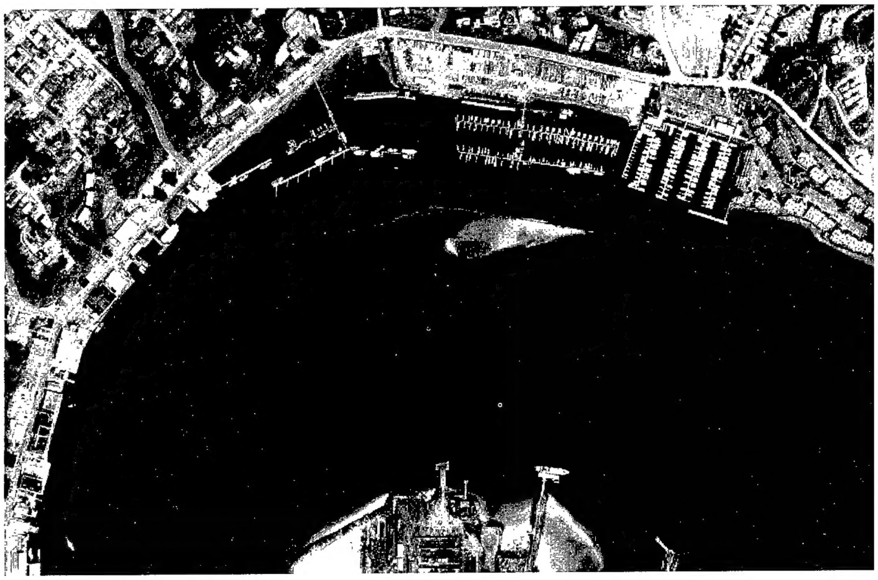


Figure 2. Aerial view of Newport North Marina

North Marina and determine the most economical breakwater modifications that would provide adequate wave protection during periods of storm wave attack. The model reproduced a portion of the Yaquina River from immediately west of the U.S. Highway 101 Bridge upstream and included Newport North Marina on the north bank as well as South Beach Marina on the south bank. It was constructed at an undistorted linear scale of 1:60, model to prototype.

Figure 3 shows detailed features included within the model limits. The total area reproduced in the model was approximately 930 sq m (10,000 sq ft), representing about 3.4 sq km (1.3 sq miles) in the prototype. A general view of the model is shown in Figure 4.

Model waves were generated by a 12.2-m-long (40-ft-long), unidirectional spectral, electrohydraulic, wave generator, which reproduced the required incident wave conditions. An automated data acquisition and control system was used to generate and transmit wave generator control signals, monitor wave generator feedback, and secure and analyze wave data at selected locations in the model. A water circulation system, consisting of a 20.3-cm (8-in.) perforated pipe water intake manifold, a 0.14-cms (5-cfs) pump, and sonic flow transducers with a multiprocessor transmitter, was used in the model to reproduce steady-state tidal flows through the lower reaches of the river. These flows corresponded

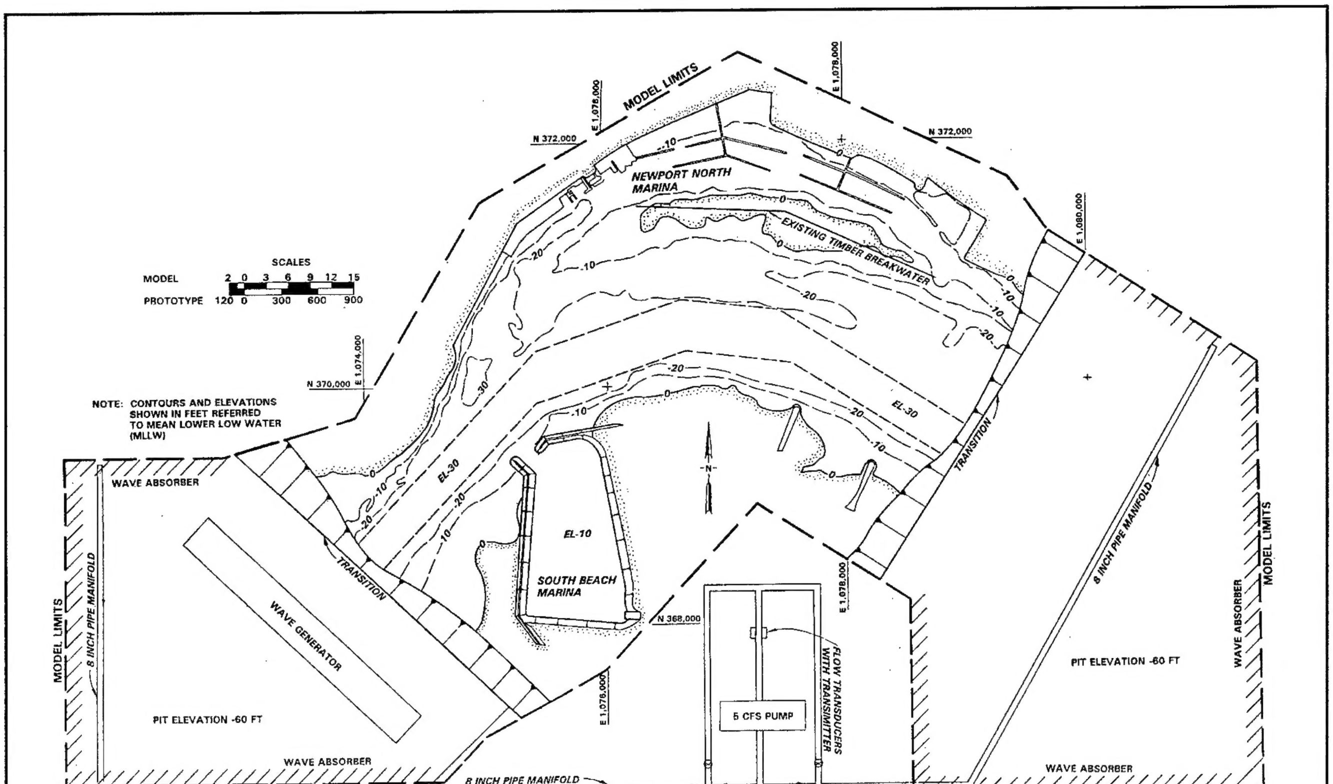


Figure 3. Model layout

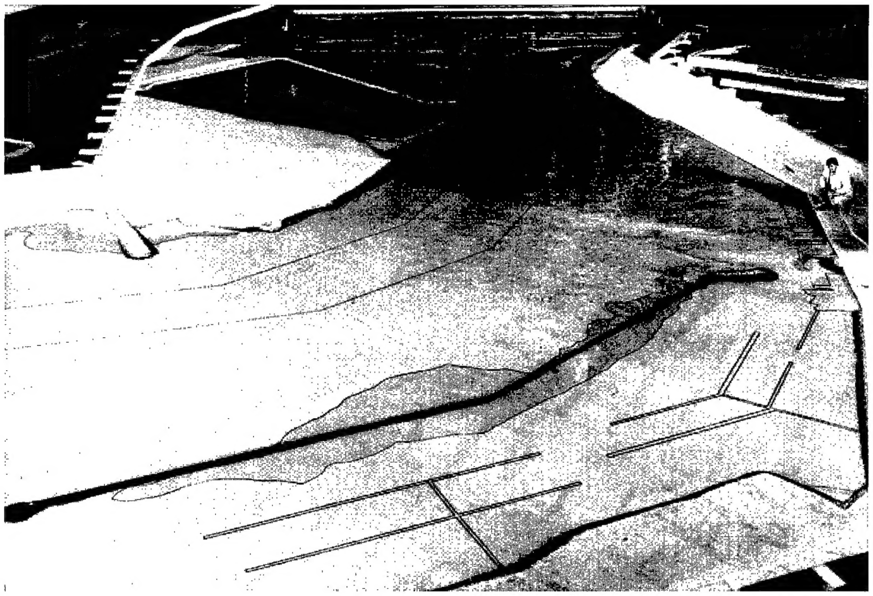


Figure 4. General view of model

to maximum flood and ebb tidal discharges measured in the prototype. The model was molded in cement mortar (fixed-bed), and a tracer material was selected to qualitatively determine movement and deposition of sediment in the vicinity immediately adjacent to the marina entrance. A solid layer of fiber wave absorber was placed at strategic locations along the inside perimeter of the model to dampen wave energy that might otherwise be reflected from the model walls.

Test Conditions

Test waves with periods ranging from 12.5 to 16.7 sec and significant heights ranging from 0.9 to 2.4 m (3 to 8 ft) were selected for reproduction in the model. Seismometer wave gauge data, covering the period 1971 to present, were available and utilized for wave height analysis. In addition, during previous studies of the Yaquina jetties, statistical wave hindcast estimates over a 20-year period (1956-1975) were available at the jettied entrance. To determine wave conditions downstream and seaward of the marina, historical records, observations, and predictions from a numerical model of wave transformation in a channel bounded by rubble-mound breakwaters were utilized. Incident wave characteristics were reproduced in the model at the approximate location of the U.S. Highway 101 Bridge. Model contours then transformed the wave characteristics as they approached the marina. Unidirectional wave spectra were reproduced using a depth-limited TMA (Texel-MARSDEN-ARSLOE) spectral form for the selected test conditions.

Still-water levels (swl's) of 0.0, +1.5, +2.4, and +3.4 m (0.0, +5.0, +8.0, and +11.0 ft) mllw were selected for use during model testing. The 0.0- and +2.4-m (0.0 and +8.0-ft) swl's were representative of mllw and mean higher high water (mhhw), respectively. The +1.5-m (+5.0-ft) swl was representative of the tidal elevation in the river when maximum flood and ebb velocities occur; therefore, tidal flows were superimposed with the +1.5-m (+5.0-ft) swl. The +3.4-m (+11.0-ft) swl represented high tide conditions (mhhw) with a 0.9-m (3.0-ft) storm surge superimposed. Prototype data indicated that maximum flood and ebb tidal velocities were 0.6 mps (1.9 fps) near the Marine Science Center (across the river from Newport North Marina). Steady-state flows with these velocities were used during model testing with the 1.5-m (+5.0-ft) swl. A crushed coal tracer material was used to qualitatively determine sediment movement patterns and subsequent deposits near the marina entrance, and an injected dye tracer was utilized to measure wave-induced current patterns and magnitudes in the model.

Experiments

Prior to studying various improvement plans, comprehensive experiments were conducted for existing conditions to establish a base from which to evaluate various alternatives. Wave heights, sediment tracer patterns, current patterns and magnitudes, and wave pattern photographs were obtained for the selected test waves. Wave height experiments revealed rough and turbulent wave conditions in the mooring areas of the marina. Significant wave heights in excess of 0.9 m (3.0 ft) were measured for the +2.4- and +3.4-m (+8.0- and +11.0-ft) swl's. Typical wave patterns obtained for existing conditions are shown in Figure 5.

Originally, three design alternatives were proposed by NPP to reduce wave energy by changing the marina entrance configuration. These included (a) straight extension of the existing breakwater to the west along the existing alignment, (b) dogleg extension of the existing breakwater to the northwest, and (c) detached breakwater positioned southwest of the existing west entrance. For an improvement plan to be acceptable, maximum significant wave heights were not to exceed 0.3 m (1.0 ft) in the existing marina mooring areas for storm wave conditions. Wave heights proposed for the originally proposed design alternatives indicated that none of the test plans met the established wave height criterion. A comparison of the straight breakwater extension concept to the angled breakwater extension concept revealed that the angled structure provided similar wave protection in the mooring areas with less breakwater length. The detached breakwater concept

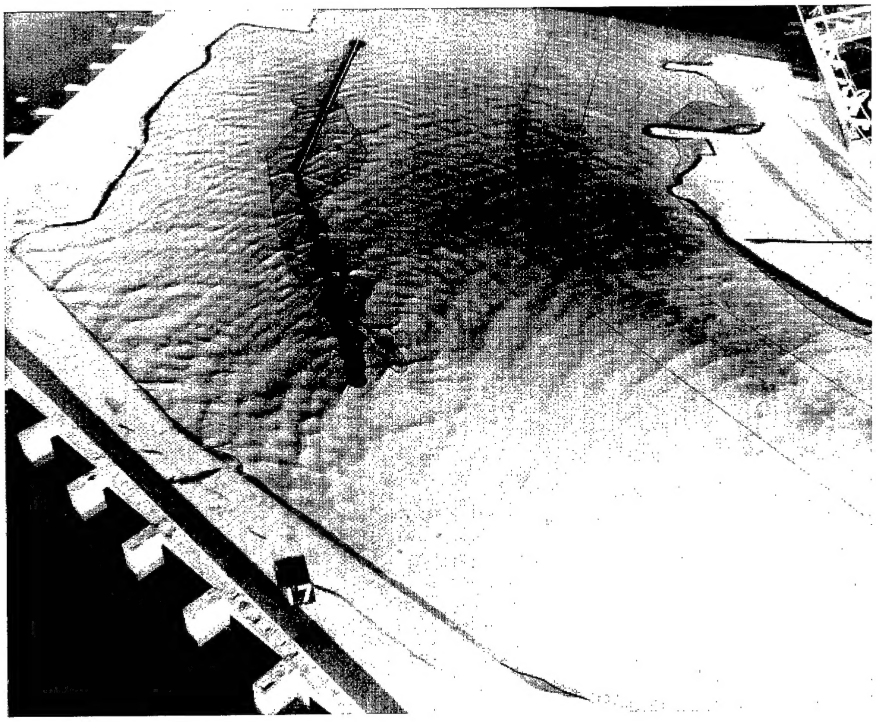


Figure 5. Existing conditions under attack by 12-sec, 2.4-m (8-ft) storm waves

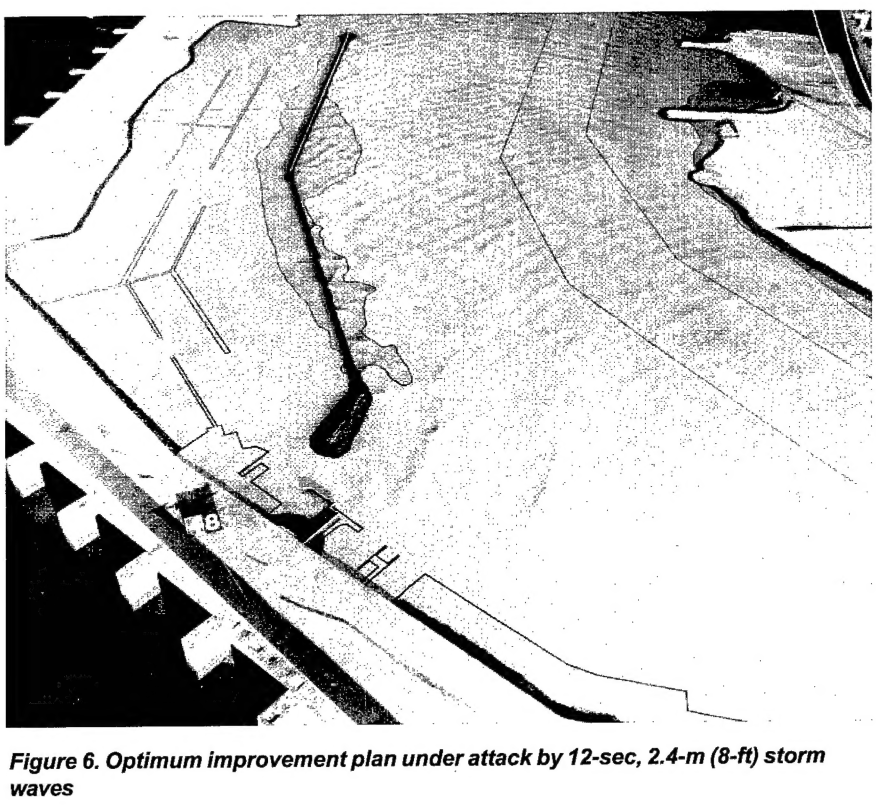


Figure 6. Optimum improvement plan under attack by 12-sec, 2.4-m (8-ft) storm waves

provided the least wave protection to the mooring areas relative to structure length versus the breakwater extensions.

Wave height experiments were conducted for 12 additional test plan configurations, with variations involving changes in lengths and alignments of the rubble-mound breakwater extensions. Solid vertical structures also were included adjacent to the existing wharves for some plans. After NPP conducted an assessment of economic benefits, an optimum improvement plan was selected considering wave protection afforded the harbor mooring areas, ease of navigation, and costs of construction. This plan consisted of a 54.9-m-long (180-ft-long) rubble-mound breakwater extension originating at the western end of the existing timber breakwater and extending in a northwesterly alignment (311-deg azimuth). This orientation resulted in a 38.1-m-wide (125-ft-wide) entrance opening. Wave patterns obtained for the optimum improvement plan are shown in Figure 6.

Additional experiments with the optimum improvement plan revealed similar circulation patterns throughout the marina as those obtained for existing conditions. Current magnitudes in the marina indicated slightly decreased velocities for the improvement plan; however, no stagnant areas were observed. Sediment tracer patterns and subsequent deposits for existing conditions were compared to the improvement plan, and indicated that sediment placed adjacent to the existing timber breakwater migrated easterly for each condition. It was concluded that if material were available for movement in the area, the breakwater extension plan would improve sedimentation conditions since material did not enter the entrance to the degree that it did for existing conditions. Comparisons of wave height data west of the existing entrance also were conducted.

Results indicated that the rubble-mound extension would have no adverse impacts on wave conditions along the existing docks and wharves in this location.

Summary

Through the application of the three-dimensional model of Newport North Marina, Yaquina Bay, Oregon, the optimum length and alignment of the breakwater extension were determined to reduce wave heights in the mooring areas to acceptable levels. The model also indicated that the improvement plan will have no negative impacts on harbor circulation, sedimentation, and wave conditions in adjacent areas. The Corps of Engineers can now construct breakwater improvements with an added degree of confidence that the project will perform as needed and that the most economical design is being used.

For additional information, contact Mr. R. R. Bottin, Jr., at (601) 634-3827, or email (r.bottin@cerc.wes.army.mil).

Mr. Bottin is a research physical scientist and principal investigator in the Wave Processes Branch, Wave Dynamics Division, Coastal Engineering Research Center, WES. He has been employed at WES since 1972 and has extensive experience managing three-dimensional hydraulic model investigations involving wave action (both long- and short-period), river discharges, tidal flows, and/or the movement of sediment. He has authored or coauthored over 100 technical publications. Mr. Bottin has a B.S. degree from the University of Southern Mississippi and is an Engineer officer with the U.S. Army Reserves.

Notes from the Front Line...

CERC/Hydraulics Labs Merge

Effective 19 October 1996, the WES Coastal Engineering Research Center (CERC) and Hydraulics Laboratory (HL) merged to form the Coastal and Hydraulics Laboratory (CHL). CHL is now the largest water-resources-development laboratory in the world. Dr. James R. Houston, former Director of CERC, has been named Director of the newly formed CHL. CERC, created by Act of Congress, has been retained as a technology center within CHL. Missions of the former CERC and HL remain unchanged within CHL.

IAPSO Homepage

The International Association for the Physical Sciences of the Oceans (IAPSO) has established a homepage at:

http://www.olympyus.net/IAPSO/

The homepage contains information about IAPSO and has links to universities, institutes, and laboratories, and links to oceanographic information including ocean experiments, models, and data sources. Links to other scientific organizations, government agencies, and World Wide Web pages of interest are also included on the homepage.

Upcoming ICCE Conferences

At the recent International Conference on Coastal Engineering (ICCE) held in Orlando, FL, information was provided on the next three ICCE conferences. The 1998 ICCE conference will be held in Copenhagen, Denmark, on 22-26 June 1998. Information on plans for that conference can be found on the ICCE conference homepage at:

http://www.dhi.dk/icce98/index.htm

The ICCE conference in the year 2000 will be held in Sydney, Australia, on 16-21 July. Information about that conference can be obtained from the conference secretariate at:

capcon@ozemail.com.au

The ICCE conference in the year 2002 will be held in Cardiff, Wales.

New Director of USACE Research and Development

Effective 1 September 1996, Dr. Lewis E. (Ed) Link, former Assistant Chief of CERC, became the new Director of Research and Development for the U.S. Army Corps of Engineers (USACE). Immediately prior to his new assignment, Dr. Link was Director of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), in Hanover, NH.

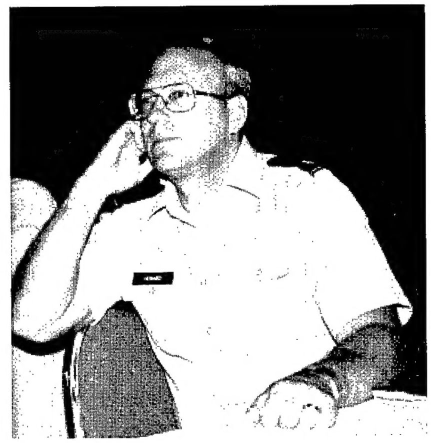
63rd Meeting of the Coastal Engineering Research Board, 11-12 June 1996, San Diego, California

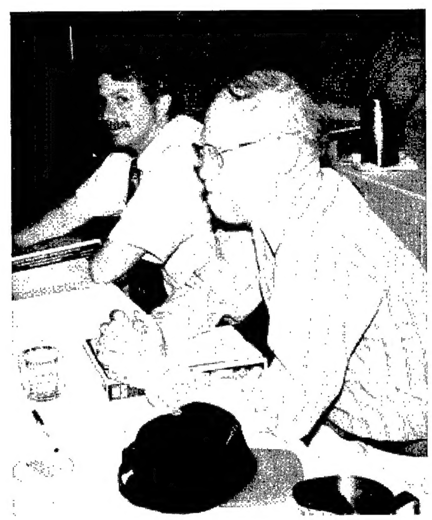
The 63rd meeting of the Coastal Engineering Research Board (CERB) was held on 11-12 June 1996, in San Diego, CA. The CERB is congressionally mandated to advise the Chief of Engineers on all matters related to coastal engineering. The Board meets twice a year in different geographical areas. The spring meeting is a full meeting of the Board, while the fall meeting format allows the civilian members to have a better understanding of the workings and problems of the host Division.

The Board is comprised of seven members. The President of the Board is MG Stanley G. Genega, Director of Civil Works. The other three military members are MG Milton Hunter, Commander, North Atlantic Division; BG Henry S. Miller, Jr., Commander, Southwestern Division; and BG Bruce K. Scott, Commander, South Pacific Division (SPD). The three civilian members are Dr. Paul D. Komar, Oregon State University; Dr. Robert G. Dean, University of Florida; and Dr. Edward K. Noda, Edward K. Noda and Associates, Inc., Honolulu, HI. The Commander of the U.S. Army Engineer Waterways Experiment Station (WES), COL Bruce K. Howard, acts as the Executive Secretary of the CERB and is responsible for all administrative functions of the board.

The theme of this meeting was "The Direction of Coastal Engineering in the Corps and the Resulting Impact on R&D." Speakers and panelists were from the Board; Headquarters, U.S. Army Corps of Engineers; SPD; Los Angeles District; academia; and the private sector. Presentations were made and discussions held on various topics pertaining to the theme of the meeting, as well as the Marine Board Study of Beach Nourishment and Protection and the Report to the Office of Management and Budget (OMB) on Shore Protection. Board members, MG Milton Hunter and Dr. Robert Dean, presented the Task Force Report entitled "Coastal Engineering into the 21st Century, a Strategic Plan for the Coastal Engineering Program of the U.S. Army Corps of Engineers," which the Board approved.

Proceedings of the meeting are located on the World Wide Web at http://bigfoot.cerc.wes.army.mil/6301.html. Since the proceedings are on the Internet, hard copies will no longer be routinely sent to Corps offices or attendees. Hard copies may be obtained from Ms. Sharon L. Hanks, WES, Coastal Engineering Research Center, (601) 634-2004.





Calendar of Coastal Events of Interest

A more complete calendar will be found on the World Wide Web at http://bigfoot.cerc.wes.army.mil/event_cal.html

Dec 2 - 6, 1996	**Natural and Technological Coastal Hazards**, Tirupati, AP, India, POC: Dr. C. Rajasekara Murthy, FAX: 905-336-4989/6230
Dec 15 - 19, 1996	**American Geophysical Union Fall Meeting**, San Francisco, California, POC: AGU Meetings, (202) 462-6900
Mar 24 - 27, 1997	**California and the World Ocean '97**, Town and Country Hotel, San Diego, California, POC: Orville Magoon, (707) 987-0114, FAX: (707) 987-9351, e-mail: otmagoon@aol.com
Apr 21 - 25, 1997	**European Geophysical Society, 22nd General Assembly**, Vienna, Austria, E-mail: egs@linax1.mpae.gwdg.de, Web: http://www.mpae.gwdg.de/EGS/EGS.html
May 25 - 30, 1997	**Offshore and Polar Engineering Conference**, Honolulu, Hawaii, POC: ISOPE-97, 303-273-3673, FAX 303-420-3760
Jul 1 - 9, 1997	**IAMAS/IAPSO Joint Assembly**, Melbourne, Australia, E-mail: mscarlett@peg.apc.org, Web: http://www.dar.csiro.au/pub/events/assemblies/info.html

Publications of Interest

The following publications and video are available from the sources indicated. They are not available from CERC.

Video, The March 1962 Storm on Long Beach Island, 1995, 90 minutes, $24. Available from Greg Hoffman, Wet Water Video Company, PO Box 1341, Beach Haven, NJ 08008.

Laboratory Study of the Effect of Sea Walls on Beach Erosion, MITSG-95-31, 1995, 158 pages, $16 plus $1.50 per domestic order or $3.00 per foreign order for shipping and handling. Order from Publications, Sea Grant Program, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139.

Marine Science Careers: A Sea Grant Guide to Ocean Opportunities, WHOI-E-96-001, 40 pages, $5. Order from Publications, WHOI Sea Grant Program, Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

Marine Structures Engineering, 1995, 568 pages, $99.95. Available from Chapman and Hall, 115 Fifth Ave., New York, NY 10003, 1-800-842-3636, FAX: 212-260-1730, e-mail: order@chaphall.com, Web: http://www.chaphall.com/chaphall.html

Optical Properties and Remote Sensing of Inland and Coastal Waters, 1995, 384 pages, $94.95 inside U.S., $114 outside U.S.; ***Oceanographic Applications of Remote Sensing***, 1995, 512 pages, $104.95 inside U.S., $126 outside U.S.; ***Wetland and Environmental Applications of GIS***, 1995, 368 pages, $69.95 inside U.S., $84 outside U.S., plus shipping and handling. Visa, MasterCard, and American Express accepted. Available from CRC Press, Inc., 2000 Corporate Blvd., N.W., Boca Raton, FL, 33431-9868, 1-800-272-7737, e-mail: orders@crcpress.com, Web: http://www.crcpress.com

A Diver's First Aid Reference to Potentially Hazardous Marine Life, Report MASGP-94-002, 1995, free. Available from Mississippi-Alabama Sea Grant Consortium, PO Box 7000, Ocean Springs, MS 39566-7000, USA. E-mail: mdbutler@ whale.st.usm.edu

US Army Corps of Engineers
Waterways Experiment Station

The Corps' Coastal Vision Statement

We will, as the National Coastal Engineer:

- **Continue our leadership in the protection, optimization, and enhancement of the Nation's coastal zone resources.**
- **Increase our contribution to the Nation's economy, quality of life, public safety, and environmental stewardship.**

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This bulletin is published in accordance with AR 25-30 as an information dissemination function of the U.S. Army Engineer Waterways Experiment Station. The publication is part of the technology transfer mission of CERC under PL 79-166 and PL 99-802. Results from ongoing research programs will be presented. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. Additional information is provided on the CERC Homepage at:

http://bigfoot.cerc.wes.army.mil/CERC_homepage.html

Contributions of pertinent information are solicited from all sources and will be considered for publication. Communications are welcomed and should be addressed to the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, ATTN: Dr. Lyndell Z. Hales, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-3207, FAX (601) 634-4253, Internet: l.hales@cerc.wes.army.mil

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